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M G. Mason

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# NITROGEN FERTILISERS FOR RAPE *(Brassica campestris and B. napus)* AND WHEAT IN WESTERN AUSTRALIA

The author: M. G. Mason, Division of Plant Research, Department of Agriculture, Western Australia.

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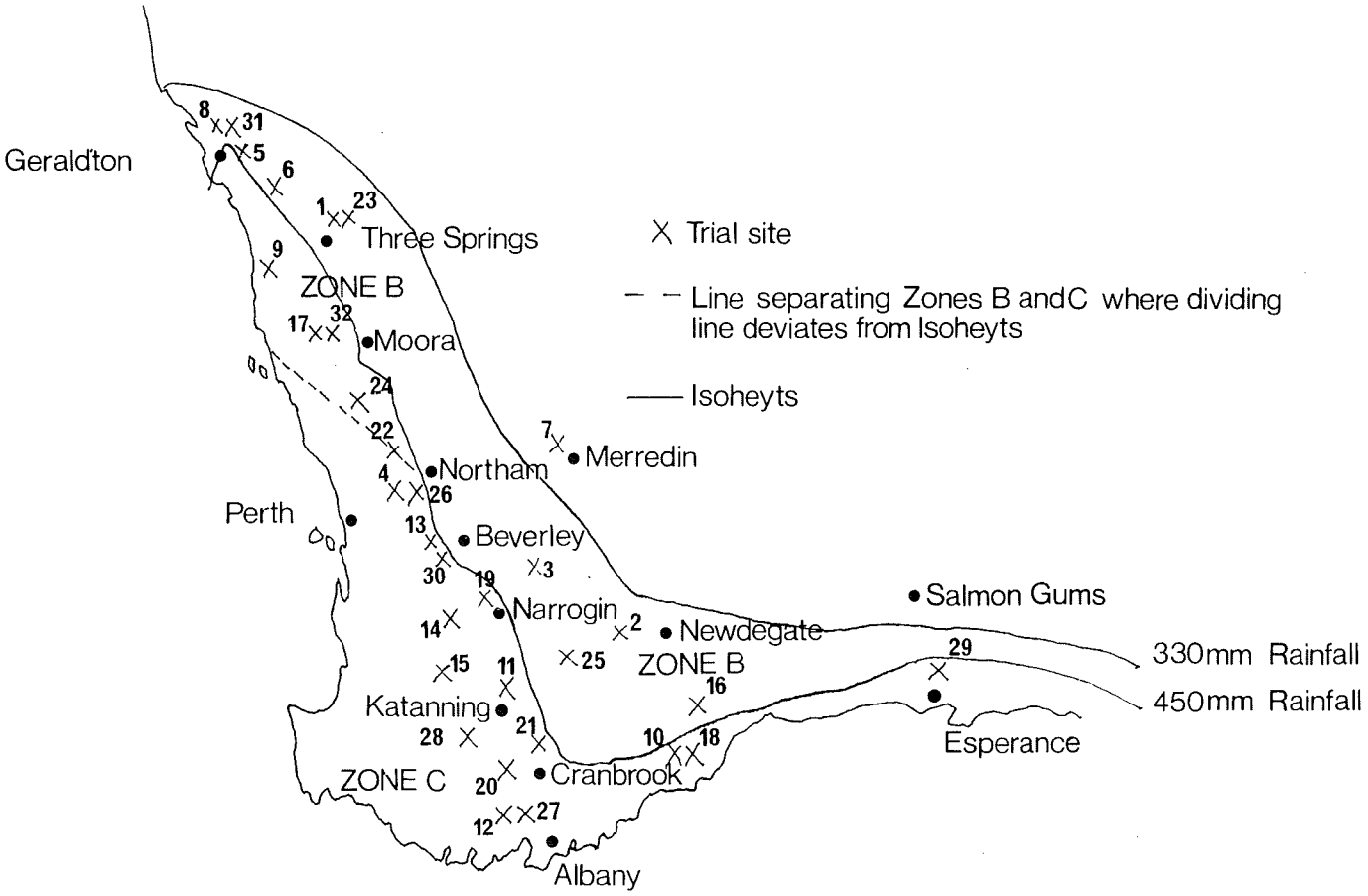


South West of Western Australia showing annual isohyets and trial sites relevant to this Bulletin.

# NITROGEN FERTILISERS FOR RAPE (*Brassica campestris* and *B. Napus*) AND WHEAT IN WESTERN AUSTRALIA

by M. G. Mason

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## SUMMARY

The response to nitrogen fertilisers by rape and wheat was compared in 32 field trials over three seasons (1971–1973). Absolute yield increases tended to be greater for wheat than rape at 63 per cent of the nitrogen responsive sites, but percentage yield increases and rate of N for maximum yield tended to be greater for rape than for wheat (63% and 57% of the responsive trials respectively).

When average response curves over all trials were considered, there was little difference between the two crops in terms of percentage responsiveness and N rate for maximum yield in areas with less than 460mm average rainfall, but in higher rainfall areas the response to N was higher for rape than for wheat.

When the economics at the time of writing were used, there were similar numbers of trials where the optimum rate of nitrogen was higher for wheat or rape. However, in areas with less than 460mm annual rainfall the optimum rate on average was higher for wheat than rape. The reverse was the case in Zone C.

This investigation did not show a consistently clear relationship between nitrogen responses on wheat and rape.

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## INTRODUCTION

Small areas of rape were grown in Western Australia in 1968 and 1969, but following imposition of wheat quotas in 1969 many farmers looking for alternative crops grew rape. By the 1971/72 season more than 28,000 hectares were sown to rape in Western Australia in spite of the fact that little was known about its agronomic and nutritional requirements under local conditions. A general outline of the crop and recommended procedures for growing it were outlined by Poole (1970).

There was a need to investigate, among other things, the various aspects involved with nitrogen fertiliser use on rape. Racz et al (1965) compared the nitrogen utilisation by rape, flax and wheat and found that a larger yield response was obtained with rape than the other two crops. Spurway, Wheeler and Hedges (1974) found that nitrogen did not significantly increase dry matter yield of rape, whereas dry matter yield of oats was increased by 50 per cent.

A large programme was commenced in 1971 to look at the effect of rates of application of nitrogen fertiliser on rape and some results on methods of application and the effects on crop establishment have already been reported (Mason 1971, 1973).

As a large volume of data is available on rates of nitrogen on wheat in Western Australia (Mason 1975), the trials were designed to compare responses to nitrogen by wheat and rape so that, hopefully, recommendations for rates of nitrogen fertiliser on rape could be based on the information available over many seasons for wheat.

## EXPERIMENTAL DETAILS

Details of soil types, sowing dates, site histories, basal fertiliser treatments, source of N fertiliser and timing of nitrogen application are shown with trial sites in Table 1. Rainfall figures for the sites are set out in Table 2. All trials had randomised block designs, with three replications except for sites 13 and 24, where there were only two replications.

Wheat was sown at 50 kg ha$^{-1}$ and rape sown at 7 kg ha$^{-1}$ mixed with superphosphate and top-dressed through the seeding machine, with the hoses out of their boots, onto the soil surface with the discs or tynes lightly cultivating. The seed was covered by trailing harrows.

The wheat variety Darkan was used on sites 11, 12, 14 and 15; Bokal at site 20 and Eagle at site 18. Other trials had Gamenya as the wheat variety. Span (B. campestris) rape was used in all 1973 trials and Arlo (B. campestris) used in all 1971 and 1972 trials except for site 2 where Target (B. napus) was planted.

Treatments are outlined in the Appendix I.

## RESULTS AND DISCUSSION

The yields obtained in the comparisons of nitrogen rates on wheat and rape are set out in Appendix I. Quadratic response curves were fitted to each crop response to nitrogen in each trial. Details of these curves together with the maximum yield increases, percentage yield increases and the rates of N which gave maximum yields are set out in Table 3. Table 4 classifies the trials according to whether the rape or wheat produced the greater absolute yield response or percentage yield response to N (percentage of yield without N). This Table also includes a grouping according to the rate of nitrogen fertiliser required to produce maximum yield. On sites 18 (Gairdner River) and 28 (Orchid Valley) maximum yields were indeterminate for rape and wheat respectively. On site 22 (Toodyay) the response curve on rape was close to a straight line and maximum yield is at an unrealistically high level. When these three trials were omitted the average yield responses and nitrogen rates required for maximum yield were as follows:–

| | Wheat greater | Rape greater |
|---|---|---|
| Absolute yield increases | Wheat 720 – Rape 220 kg ha$^{-1}$ | Wheat 220 – Rape 1163 kg ha$^{-1}$ |
| % yield increases | Wheat 33.5 – Rape 18% | Wheat 50 – Rape 193% |
| N rate for maximum yield | Wheat 105 – Rape 58 kg ha$^{-1}$ | Wheat 78 – Rape 173 kg ha$^{-1}$ |

Average response curves for all 32 trials and also for 13 trials in Zone B (see Figure) (approximately 330–460mm average annual rainfall – Mason 1975) and 18 trials in Zone C (over 460mm average annual rainfall) are presented in Table 5, together with maximum yield increases, percentage yield increases and nitrogen rates required for maximum yields for these aggregated trials.

While absolute increases in yield, due to nitrogen fertiliser application, were generally greater for wheat (63% of responsive sites) than rape, the percentage yield increases (63% of responsive sites) and rates of nitrogen fertiliser required for maximum yield (57% of responsive sites) tended to be higher for rape. Examination of the average response curves for the different rainfall zones (Table 5) suggests that this difference in responsiveness could depend on the area in which the crops are grown. In Zone B there was little difference in the percentage responsiveness of the two crops and the rate of nitrogen required for maximum yield was a little higher for wheat than for rape. However, in Zone C, where rape growing is more suited, both the percentage responsiveness and the rate of nitrogen fertiliser required for maximum yield were higher for rape than for wheat.

Table 6 sets out the optimum "economic" rate of nitrogen for rape and wheat for each of the trials and groups these trials according to whether this rate is higher for wheat or rape. This exercise assumes a return of \$85 tonne$^{-1}$ for wheat and \$165 tonne$^{-1}$ for rape and a nitrogen cost of \$400 tonne$^{-1}$ of nitrogen. There were similar numbers of trials in each of these groups, although difference in optimum nitrogen rate for wheat and rape was greater in the group where more was required on rape, than in the group where higher rates of N were profitable on wheat.

When these economic considerations were applied to the average response curves, the following were the most profitable rates:–

| | | |
|---|---|---|
| Total of all trials | – wheat 48 kg N ha$^{-1}$, | rape 45 kg N ha$^{-1}$ |
| Zone B | – wheat 50 kg N ha$^{-1}$, | rape 19 kg N ha$^{-1}$ |
| Zone C | – wheat 45 kg N ha$^{-1}$, | rape 63 kg N ha$^{-1}$ |

While it appears that rape is more responsive than wheat to nitrogen fertilisers, in terms of percentage response and rate of nitrogen required to give "maximum" yield, overall, the response curve for rape appears to be longer and more gradual than for wheat and therefore rates of nitrogen for maximum profit differ less between the crops than for yield response. It would appear that because of the higher per unit value for rape, higher rates of nitrogen should be applied to rape crops than to wheat crops in the higher rainfall areas. However, the relationship between nitrogen requirement for wheat and rape is far from clear and consistent and the only guide for comparison from these results is to compare the "average" responses and the frequency of differences.

## ACKNOWLEDGMENTS

Thanks are due to the many farmers who made land available for many of these trials, the research station managers and technical staff, the advisers and technical staff of the district offices of the Department of Agriculture and the Division of Plant Research technical staff who helped plant and harvest the trials. Thanks are also due to the Biometrics Section of the Department of Agriculture for fitting response curves to the yield data.

## REFERENCES

Mason, M.G. (1971): – Effects of urea, ammonium nitrate and super-phosphate on establishment of cereals, linseed and rape. Aust. J. Exp. Agric. and An. Husb. 11: 662.

Mason, M.G. (1973): – Glasshouse trials with nitrogen and phosphate on rapeseed, lupins, peas, safflower and sunflower – 1971. W.A. Dept. Agric. Tech. Bu.

Mason, M.G. (1975): – Nitrogenous fertilisers for cereal production. J. Agric. W. Aust. (Series 4) 16: 103.

Poole, M.L. (1970): – Rapeseed production in Western Australia. J. Agric. W. Aust. (Series 4) 11: 73.

Racz, G.J., Webber, M.D., Soper, R.J. and Hedlin, R.A. (1965): – Phosphorus and nitrogen utilisation by rape, flax and wheat. Agron., J. 57: 335.

Spurway, R.A., Wheeler, F.L. and Hedges, D.A. (1974): – Forage and sheep production from oats, rape and vetch sown in autumn with or without nitrogen fertilizer. Aust. J. Exp. Agric. and An. Husb. 14: 619

## APPENDIX 1

**Seed yields (kg/ha) in trials comparing rates of nitrogen fertiliser for wheat and rape.**

| Site | | Rate of N (kg/ha) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 12.9 | 25.8 | 38.6 | 51.5 | 77.3 | 103 | 154.6 |
| 1. 71TS2 — Three Springs | Wheat | 1278 | 1603 | 1814 | 1888 | 2075 | 2389 | | 2497 |
| | Rape | 285 | 393 | 403 | 521 | 536 | 678 | | 973 |
| 2. 71N4 — Newdegate | Wheat | 1713 | 1713 | 2002 | 1769 | 2018 | 1561 | | 1833 |
| | Rape | 697 | 841 | 881 | 953 | 961 | 849 | | 1073 |
| 3. 71NA2 — Yealering | Wheat | 1180 | 1265 | 1308 | 1374 | 1382 | 1329 | | 1249 |
| | Rape | 358 | 363 | 411 | 395 | 427 | 411 | | 384 |
| 4. 71NO1 — West York | Wheat | 2082 | 2434 | 2274 | 2541 | 3021 | 3480 | | 3245 |
| | Rape | 854 | 758 | 982 | 1217 | 1089 | 1302 | | 1260 |
| 5. 71GE2 — Eradu | Wheat | 1868 | 2146 | 2348 | 2594 | 2626 | 2680 | 2637* | |
| | Rape | 235 | 331 | 320 | 331 | 384 | 374 | 416 | |
| 6. 71GE3 — Allanooka | Wheat | 3000 | 3085 | 3106 | 2829 | 2850 | 2776 | | 3000 |
| | Rape | 267 | 448 | 470 | 384 | 470 | 310 | | 117 |
| 7. 71M2 — Merredin | Wheat | 1922 | 2338 | 2562 | 2434 | 2594 | 2776 | | 2562 |
| | Rape | 614 | 646 | 742 | 774 | 694 | 689 | | 747 |
| 8. 71C1 — Nabawa | Wheat | 3106 | 3512 | 3715 | 3469 | 3608 | 3619 | 3459** | |
| | Rape | 598 | 662 | 801 | 705 | 822 | 801 | 587 | |

* N 129 kg/ha

** N 198 kg/ha

## APPENDIX 1 (Cont.)

**Seed yield (kg/ha)**

| Site | | Rate of N (kg/ha) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 12.9 | 25.8 | 38.6 | 51.5 | 77.3 | 103 | 154.6 |
| 9. 71TS1 — Eneabba | Wheat | 2615 | 2733 | 2776 | 2744 | 2712 | 2813 | | 2781 |
| | Rape | 566 | 571 | 496 | 470 | 560 | 379 | | 208 |
| 10. 71JE2 — Gairdner River | Wheat | 1598 | 2025 | 2003 | 2060 | 2046 | 2057 | | 1918 |
| | Rape | 648 | 641 | 655 | 690 | 690 | 626 | | 697 |
| 11. 71KA1 — Katanning | Wheat | 2290 | 2188 | 1628 | 1612 | 1607 | 1228 | | 881 |
| | Rape | 1804 | 1633 | 1751 | 1569 | 1607 | 1559 | | 1740 |
| 12. 71MT2 — Mount Barker | Wheat | 1495 | 1740 | 1697 | 1623 | 1441 | 1665 | 1655 | |
| | Rape | 1046 | 1185 | 1228 | 1153 | 1292 | 1094 | 1196 | |
| 13. 71A2 — Beverley | Wheat | 2562 | 2167 | 2466 | 2092 | 2487 | 2402 | | 1847 |
| | Rape | 1228 | 1345 | 1377 | 1228 | 1420 | 1409 | | 1452 |
| 14. 71NA1 — Williams | Wheat | 4121 | 3993 | 4516 | 4452 | 4398 | 3928 | | 3074 |
| | Rape | 566 | 721 | 726 | 619 | 833 | 913 | | 1068 |
| 15. 71BR1 — Duranillin | Wheat | 2349 | 2893 | 3187 | 3283 | 3196 | 3203 | | 2679 |
| | Rape | 1126 | 1233 | 1398 | 1516 | 1740 | 1756 | | 1820 |
| 16. 71JE1 — Jacup | Wheat | 2790 | 2956 | 3136 | 3107 | 3103 | 3088 | | 2679 |
| | Rape | 637 | 633 | 670 | 670 | 751 | 622 | | 541 |
| 17. 71BA2 — Badgingarra | Wheat | 1687 | 1939 | 2073 | 2168 | 2254 | 2444 | | 2538 |
| | Rape | 818 | 1011 | 939 | 1117 | 1075 | 1124 | | 740 |

## APPENDIX 1 (Cont.)

### Seed yield (kg/ha)

| Site | | Rate of N (kg/ha) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 12.9 | 25.8 | 38.6 | 51.5 | 77.3 | 103 | 154.6 |
| 18. 71JE20 — Gairdner River | Wheat | 1964 | 2035 | 1840 | 2085 | 2003 | 1964 | | |
| | Rape | 1075 | 1021 | 1153 | 1153 | 1231 | 1352 | | |
| 19. 71NA3 — Narrogin | Wheat | 1414 | 1756 | 1825 | 1959 | 2018 | 2397 | | 2252 |
| | Rape | 785 | 971 | 907 | 1025 | 1105 | 1110 | | 1201 |
| 20. 71AL2 — Frankland | Wheat | 673 | 982 | 1078 | 1100 | 1441 | 1505 | | 1420 |
| | Rape | 504 | 820 | 936 | 1050 | 1308 | 1321 | | 2090 |
| 21. 71KA2 — Tambellup | Wheat | 598 | 571 | 566 | 603 | 544 | 534 | | 470 |
| | Rape | 1254 | 1329 | 1473 | 1473 | 1532 | 1468 | | 1633 |
| 22. 72NO1 — Toodyay | Wheat | 1544 | | 1708 | 2071 | 2185 | 2306 | 2014 | 2007 |
| | Rape | 790 | | 975 | 1068 | 1075 | 1082 | 1352 | 1537 |
| 23. 72TS4—East Three Springs | Wheat | 1003 | | 1404 | 1345 | 1441 | 1681 | 1831 | 1954 |
| | Rape | 128 | | 192 | 219 | 331 | 363 | 507 | 523 |
| 24. 72MO9 — Gillingarra | Wheat | 480 | 567 | 720 | 782 | 1085 | 987 | | 1236 |
| | Rape | 142 | 178 | 231 | 391 | 284 | 391 | | 373 |
| 25. 72LG2 — Moulyinning | Wheat | 1126 | | 1393 | 1297 | 1377 | 1420 | 1366 | 1521 |
| | Rape | 149 | | 181 | 208 | 214 | 181 | 214 | 187 |
| 26. 73NO2 — West York | Wheat | 789 | | 1199 | 1562 | 1720 | 1831 | 2099 | 2557 |
| | Rape | 79 | | 253 | 316 | 347 | 473 | 568 | 710 |
| 27. 73MT3 — Mt. Barker | Wheat | 3149 | 3253 | 3580 | 3717 | 3568 | 3764 | | |
| | Rape | 481 | 552 | 566 | 587 | 649 | 545 | | |
| 28. 73KA1 — Orchid Valley | Wheat | 1113 | | 1409 | 1243 | 1610 | 1373 | 1858 | 2214 |
| | Rape | 107 | | 154 | 128 | 201 | 237 | 270 | 320 |
| 29. 73E1 — Gibson | Wheat | 3054 | 3291 | 3350 | 3741 | 3906 | 3847 | | |
| | Rape | 279 | 336 | 341 | 369 | 322 | 391 | | |
| 30. 73A2 — Beverley | Wheat | 3015 | 3251 | 3539 | 3687 | 3832 | 3693 | | |
| | Rape | 212 | 401 | 388 | 477 | 562 | 584 | | |
| 31. 73C1 — Nabawa | Wheat | 2661 | 2885 | 3021 | 3128 | 3177 | 3141 | | |
| | Rape | 833 | 881 | 917 | 893 | 976 | 893 | | |
| 32. 73BA1 — Badgingarra | Wheat | 357 | 447 | 289 | 289 | 748 | 767 | | |
| | Rape | 495 | 547 | 459 | 410 | 540 | 523 | | |

**Table 1 — Some details of experiments investigating aspects of nitrogen fertiliser use on rape**

| Site | Soil type | Sowing Date | Site History | Basal Fertiliser | Source of N and timing of nitrogen application |
|---|---|---|---|---|---|
| 1. Three Springs | Red-brown clay loam | 12/6/71 | Fourth successive crop on old medic country Stubble of previous crop grazed and ploughed in. | Superphosphate 134 kg ha−1 | Urea I.B.S. |
| 2. Newdegate | Grey brown sand over gravel | 9/6/71 | Second successive crop on old clover land. Stubble of previous crop burnt. | Superphosphate 168 kg ha−1 | Ammonium Nitrate I.B.S. |
| 3. Yealering | Red-brown sandy loam with some gravel. Morrell, | 10/6/71 | Second successive crop on old clover land. Stubble of previous crop burnt. | Copper, Zinc, Molybdenum, 140 kg ha−1 | Ammonium Nitrate I.B.S. |
| 4. West York | Grey brown loamy sand over gravel | 11/6/71 | First crop after sub-terranean clover pasture pasture on old land | Superphosphate 134 kg ha−1 | Ammonium Nitrate I.B.S. |
| 5. Eradu | Deep earthy yellow sand | 18/6/71 | First crop after 4 years Geraldton sub-clover-Harbinger medic pasture | Superphosphate 180 kg ha−1 | Ammonium Nitrate I.B.S. |
| 6. Allanooka | Sandy loam with gravel over clay at 15-30 cm | 28/6/71 | First crop after 7 years Geraldton sub-clover pasture | Superphosphate 180 kg ha−1 | Urea I.B.S. |
| 7. Merredin | Grey-yellow loamy sand with mottling at 22 cm, over clay | 2/6/71 | Second successive crop on old clover land. Stubble of previous crop burnt. | Copper, Zinc, Molybdenum, Superphosphate 190 kg ha−1 | Ammonium Nitrate I.B.S. |
| 8. Nabawa | Red-brown sandy loam | 24/6/71 | Second successive crop on old clover land. Stubble of previous crop burnt. | Superphosphate 168 kg ha−1 | Ammonium Nitrate I.B.S. |
| 9. Eneabba | Sand over gravel at about 45 cm | 28/6/71 | First crop after clover on old land. | Copper, Zinc, Superphosphate 175 kg ha−1 | Ammonium Nitrate I.B.S. |
| 10. Gairdner River | Gravelly sand over gravelly clay | 26/5/71 | First crop after sub-clover pasture. | Superphosphate 168 kg ha−1 | Ammonium Nitrate I.B.S. |
| 11. Katanning | Grey-brown fine loamy sand over gravel and clay at 12 cm. | 24/5/71 | First crop after clover on old land. | Superphosphate 108 kg ha−1 | Urea I.B.S. |
| 12. Mount Barker | Brown loamy sand with gravel | 29/5/71 | Second successive crop on old clover land. Stubble of previous crop burnt. | Superphosphate 168 kg ha−1 | Urea I.B.S. |
| 13. Beverley | Red-brown sandy clay loam | 12/6/71 | Second successive crop on old clover land. Stubble of previous crop burnt. | Superphosphate 134 kg ha−1 | Ammonium Nitrate I.B.S. |
| 14. Williams | Grey sand over clay | 1/6/71 | First crop after clover on old land. | Copper, Zinc, Molybdenum, Superphosphate 140 kg ha−1 | Urea 4 weeks after sowing |
| 15. Duranillin | Brown sandy loam over yellow sandy loam at 30 cm with yellow sandy gravel at 75 cm | 9/6/71 | First crop after 4 years of good clover pasture. | Superphosphate 200 kg ha−1 | Ammonium Nitrate 3 weeks after sowing |
| 16. Jacup | White-grey sand over clay at 45-60 cm | 25/5/71 | First crop after 4 years clover pasture. | Superphosphate 168 kg ha−1 | Ammonium Nitrate I.B.S. |

**Table 1 (Cont.)**

| Site | Soil type | Sowing Date | Site History | Basal Fertiliser | Source of N and timing of nitrogen application |
|---|---|---|---|---|---|
| 17. Badgingarra | Grey sand over gravel | 11/6/71 | Second successive crop on old clover land. Stubble of previous crop burnt. | Superphosphate 168 kg ha−1 | Ammonium Nitrate I.B.S. |
| 18. Gairdner River | Gravelly sand over gravelly clay | 3/6/71 | First crop after 3 years clover pasture. | Superphosphate 200 kg ha−1 | Ammonium Nitrate I.B.S. |
| 19. Narrogin | Gravelly loamy sand to loamy sand | 8/6/71 | Second successive crop on old clover land. Stubble of previous crop burnt. | Copper, Zinc, Molybdenum, Superphosphate 140 kg ha−1 | Urea I.B.S. |
| 20. Frankland | Gravelly loam over clay at 45 cm | 12/5/71 | Second successive crop on old clover land. Stubble of previous linseed crop burnt. | Superphosphate 200 kg ha−1 | Ammonium Nitrate 4 weeks after sowing |
| 21. Tambellup | Sand over clay at 25 cm | 9/6/71 | First crop after clover on old land. | Superphosphate 100 kg ha−1 | Ammonium Nitrate 2 weeks before sowing |
| 22. Toodyay | Red-brown clay loam | 23/6/72 | Second successive crop on old clover land. | Superphosphate 168 kg ha−1 | Urea 4 weeks after sowing |
| 23. Three Springs | Red-brown sand over gravel | 13/6/72 | First crop after clover on old land. | Superphosphate 134 kg ha−1 | Urea 3 weeks after sowing |
| 24. Gillingarra | Very gravelly sand over gravel | 15/6/72 | Second successive crop after 9 years clover pasture. Stubble of previous crop NOT burnt. | Superphosphate 180 kg ha−1 | Urea 3 weeks after sowing |
| 25. Moulyinning | Grey loamy sand over yellow brown clay – loam at 15 cm | 27/6/72 | First crop after 1 year volunteer pasture on land cropped every second year. | Superphosphate 168 kg ha−1 | Urea 2 weeks after sowing |
| 26. West York | Gravelly loamy sand over clay at about 35 cm | 2/7/73 | Third successive crop on old clover land. Previous two crops cut for hay. | Superphosphate 140 kg ha−1 | Urea 3 weeks after sowing |
| 27. Mount Barker | Grey-yellow gravelly loamy sand over gravelly clay at 20 cm. | 24/5/73 | First crop after clover on old land. | Superphosphate 140 kg ha−1 | Urea 3 weeks after sowing |
| 28. Orchid Valley | Grey-brown gravelly loamy sand over clay at 45 cm | 12/6/73 | First crop after poor clover on relatively new land. | Superphosphate 168 kg ha−1 | Urea 3 weeks after sowing |
| 29. Gibson | Gravelly sand over gravelly clay | 11/7/73 | First crop after clover on old land. | Superphosphate 140 kg ha−1 | Urea 7 weeks after sowing |
| 30. Beverley | Grey-brown to yellow loamy sand over grey-yellow gritty sand becoming coarser with depth. | 15/6/73 | First crop after clover on old land. | Superphosphate 140 kg ha−1 | Urea 3 weeks after sowing |
| 31. Nabawa | Red-brown loamy sand | 21/6/73 | First crop after clover on old land. | Superphosphate 140 kg ha−1 | Urea 3 weeks after sowing |
| 32. Badgingarra | Gravelly sand over gravel | 5/6/73 | First crop after clover on old land. | Superphosphate 140 kg ha−1 | Urea 3 weeks after sowing |

**Table 2 — Rainfall at centres near 48 trial sites in the year of the trial and the long term average**

| Site and year | Season of trial | | Long term averages | |
|---|---|---|---|---|
| | May — October | Year | May — October | Year |
| | (mm) | (mm) | (mm) | (mm) |
| Three Springs 1971 | 202 | 377 | 306 | 397 |
| Newdegate Res. Station 1971 | 199 | 489 | 261 | 393 |
| Yealering 1971 | 224 | 359 | 290 | 381 |
| West York 1971 | 327 | 440 | 357 | 440 |
| Eradu | 264 | 480 | 325 | 404 |
| Allanooka 1971 | 293 | 412 | 407 | 475 |
| Merredin Res. Station 1971 | 136 | 338 | 196 | 282 |
| Chapman Res. Stn. (Nabawa) 1971 | 323 | 454 | 381 | 449 |
| Eneabba 1971 | 381 | 483 | 513 | 591 |
| Gairdner River 1971 | 249 | 657 | 323 | 471 |
| Katanning 1971 | 396 | 661 | 373 | 493 |
| Mt. Barker Res. Stn. 1971 | 508 | 787 | 449 | 622 |
| Avondale Res. Stn. (Beverley) 1971 | 237 | 348 | 303 | 384 |
| Williams 1971 | 252 | 594 | 310 | 443 |
| Duranillin 1971 | 411 | 621 | 421 | 564 |
| Jacup 1971 | 182 | 532 | 256 | 415 |
| Badgingarra REs. Station 1971 | 384 | 537 | 508 | 619 |
| Narrogin 1971 | 348 | 561 | 403 | 509 |
| Frankland 1971 | 443 | 671 | 478 | 616 |
| Tambellup 1971 | 327 | 643 | 343 | 474 |
| Toodyay | 316 | 349 | 449 | 541 |
| Three Springs 1972 | 318 | 362 | 306 | 397 |
| Gillingarra 1972 | 341 | 473 | 520 | 617 |
| Moulyinning 1972 | 205 | 233 | 257 | 352 |
| West York 1973 | 594 | 644 | 357 | 440 |
| Mt. Barker Res. Stn. 1973 | 518 | 692 | 449 | 622 |
| Orchid Valley | 410 | 517 | 427 | 548 |
| Esperance Downs Res. Stn. (Gibson) 1973 | 362 | 503 | 327 | 486 |
| Avondale Res. Stn. (Beverley) 1973 | 347 | 385 | 303 | 378 |
| Chapman Res. Stn. (Nabawa) 1973 | 414 | 452 | 381 | 449 |
| Badgingarra Res. Stn. 1973 | 638 | 703 | 503 | 619 |

**Table 3 — Fitted response curves, maximum and percentage yield increases and rates of N fertiliser required for maximum yield for trials comparing rates of nitrogen fertiliser on wheat and rape.**

| Trial | Crop | Fitted response curve | $R^2$ | Maximum yield increase (kg/ha) | % yield increase | N rate to give maximum |
|---|---|---|---|---|---|---|
| | | | | (kg/ha) | % | (kg/ha) |
| 1. | Wheat | $Y = 1315.2 + 19.3N - 0.075N^2$ | 98.9 | 1242 | 94 | 129 |
| | Rape | $Y = 296.6 + 5.37N - 0.006N^2$ | 99.1 | 1202 | 405 | 448 |
| 2. | Wheat | $Y = 1793.5 + 0.36N - 0.002N^2$ | 0.1 (N.S.) | 16 | 1 | 90 |
| | Rape | $Y = 772.3 + 3.24N - 0.009N^2$ | 65.5 | 292 | 38 | 180 |
| 3. | Wheat | $Y = 1207.6 + 4.33N - 0.027N^2$ | 81.3 | 174 | 14 | 80 |
| | Rape | $Y = 358.2 + 1.53N - 0.009N^2$ | 75.8 (N.S.) | 65 | 18 | 85 |
| 4. | Wheat | $Y = 1978.1 + 24.56N - 0.104N^2$ | 87.0 | 1450 | 73 | 118 |
| | Rape | $Y = 772.3 + 9.9N - 0.043N^2$ | 81.8 (N.S.) | 570 | 74 | 115 |
| 5. | Wheat | $Y = 1907.8 + 19.58N - 0.109N^2$ | 96.7 | 879 | 46 | 90 |
| | Rape | $Y = 262 + 2.56N - 0.011N^2$ | 84.5 | 149 | 57 | 116 |
| 6. | Wheat | $Y = 3102 - 6.68N + 0.038N^2$ | 57.0 (N.S.) | 0 | 0 | 0 |
| | Rape | $Y = 354.1 + 2.61N - 0.027N^2$ | 73.6 (N.S.) | 63 | 18 | 48 |
| 7. | Wheat | $Y = 2044.3 + 15.78N - 0.081N^2$ | 85.3 | 769 | 38 | 97 |
| | Rape | $Y = 646.3 + 1.85N - 0.008N^2$ | 37.1 (N.S.) | 107 | 17 | 116 |
| 8. | Wheat | $Y = 3297.3 + 8.05N - 0.037N^2$ | 48.3 (N.S.) | 438 | 13 | 109 |
| | Rape | $Y = 620.8 - 4.49N - 0.024N^2$ | 80.1 | 210 | 34 | 94 |
| 9. | Wheat | $Y = 2659.3 + 2.83N - 0.013N^2$ | 60.3 (N.S.) | 154 | 6 | 109 |
| | Rape | $Y = 571.3 - 1.59N - 0.005N^2$ | 89.4 | 0 | 0 | 0 |
| 10. | Wheat | $Y = 1757.3 + 8.86N - 0.051N^2$ | 61.9 (N.S.) | 385 | 22 | 87 |
| | Rape | $Y = 653.5 + 0.13N + 0.0007N^2$ | 21.4 (N.S.) | 0 | 0 | 0* |
| 11. | Wheat | $Y = 2281.5 - 18.52N + 0.062N^2$ | 94.5 | 0 | 0 | 0 |
| | Rape | $Y = 1777 - 5.34N + 0.033N^2$ | 68.2 (N.S.) | 0 | 0 | 0 |
| | Wheat | $Y = 1611.4 - 0.18N + 0.003N^2$ | 2.2 (N.S.) | 0 | 0 | 0 |
| | Rape | $Y = 1123.1 + 1.86N - 0.01N^2$ | 12.4 (N.S.) | 86 | 8 | 93 |
| 13. | Wheat | $Y = 2370 + 1.17N - 0.028N^2$ | 51.1 (N.S.) | 12 | 0.5 | 21 |
| | Rape | $Y = 1262.8 + 2.54N - 0.009N^2$ | 52.2 (N.S.) | 179 | 14 | 141 |
| 14. | Wheat | $Y = 4143 + 8.1N - 0.099N^2$ | 86.1 | 166 | 4 | 41 |
| | Rape | $Y = 593.7 + 4.37N - 0.008N^2$ | 85.6 | 597 | 101 | 273 |
| 15. | Wheat | $Y = 2557.2 + 20.44N - 0.129N^2$ | 81.0 | 810 | 32 | 79 |
| | Rape | $Y = 1103.3 + 13.5N - 0.057N^2$ | 97.0 | 799 | 72 | 118 |
| 16. | Wheat | $Y = 2858.3 + 7.91N - 0.054N^2$ | 83.4 | 290 | 10 | 73 |
| | Rape | $Y = 635.2 + 1.65N - 0.015N^2$ | 66.0 (N.S.) | 45 | 7 | 55 |
| 17. | Wheat | $Y = 1731.3 + 13.4N - 0.053N^2$ | 98.9 | 847 | 49 | 126 |
| | Rape | $Y = 846.9 + 7.78N - 0.055N^2$ | 89.1 | 275 | 32 | 71 |
| 18. | Wheat | $Y = 1961.8 + 1.15N - 0.016N^2$ | 2.2 (N.S.) | 21 | 1 | 36 |
| | Rape | $Y = 1049.6 + 1.93N + 0.027N^2$ | 91.9 | — | — | —* |
| 19. | Wheat | $Y = 1449.9 + 16.92N - 0.075N^2$ | 95.1 | 954 | 66 | 113 |
| | Rape | $Y = 765 + 12.21N - 0.111N^2$ | 97.7 | 336 | 44 | 55 |
| 20. | Wheat | $Y = 705.9 + 16.39N - 0.076N^2$ | 94.2 | 884 | 125 | 108 |
| | Rape | $Y = 593.5 + 12.73N - 0.021N^2$ | 97.1 | 1929 | 325 | 303 |
| 21. | Wheat | $Y = 592.4 - 0.60N - 0.001N^2$ | 85.3 | 0 | 0 | 0 |
| | Rape | $Y = 1294 + 4.66N - 0.017N^2$ | 82.0 | 319 | 25 | 137 |
| 22. | Wheat | $Y = 1539.2 + 14.39N - 0.076N^2$ | 76.8 (N.S.) | 681 | 44 | 95 |
| | Rape | $Y = 824 + 4.83N - 0.001N^2$ | 94.8 | 5832 | 708 | 2415 |
| 23. | Wheat | $Y = 1032.8 + 10.6N - 0.03N^2$ | 96.6 | 936 | 91 | 177 |
| | Rape | $Y = 100.5 + 4.61N - 0.011N^2$ | 94.9 | 483 | 481 | 210 |
| 24. | Wheat | $Y = 468.2 + 10.89N - 0.039N^2$ | 91.9 | 760 | 162 | 140 |
| | Rape | $Y = 136.4 + 5.12N - 0.023N^2$ | 81.1 (N.S.) | 285 | 209 | 111 |
| 25. | Wheat | $Y = 1194.3 + 3.67N - 0.011N^2$ | 70.3 | 306 | 26 | 167 |
| | Rape | $Y = 156.7 + 1.17N - 0.006N^2$ | 60.6 (N.S.) | 57 | 36 | 98 |
| 26. | Wheat | $Y = 837.2 + 17.17N - 0.041N^2$ | 97.7 | 1798 | 215 | 209 |
| | Rape | $Y = 90.1 + 5.99N - 0.013N^2$ | 99.6 | 690 | 766 | 230 |
| 27. | Wheat | $Y = 3133.9 + 17.47N - 0.125N^2$ | 86.7 | 610 | 19 | 70 |
| | Rape | $Y = 477.9 + 5.78N - 0.062N^2$ | 83.6 (N.S.) | 135 | 28 | 47 |
| 28. | Wheat | $Y = 1169.4 + 4.16N + 0.017N^2$ | 86.5 | | | —* |
| | Rape | $Y = 98.7 + 1.89N - 0.003N^2$ | 94.6 | 298 | 302 | 315 |
| 29. | Wheat | $Y = 3008.4 + 23.7N - 0.16N^2$ | 92.8 | 878 | 29 | 74 |
| | Rape | $Y = 295.7 + 1.72N - 0.008N^2$ | 62.2 (N.S.) | 92 | 31 | 108 |
| 30. | Wheat | $Y = 2981.4 + 27.84N - 0.238N^2$ | 98.7 | 814 | 27 | 58 |
| | Rape | $Y = 235.2 + 8.85N - 0.056N^2$ | 93.2 | 350 | 149 | 79 |
| 31. | Wheat | $Y = 2668.1 + 17.71N - 0.15N^2$ | 99.9 | 523 | 20 | 59 |
| | Rape | $Y = 830.4 + 4.36N - 0.045N^2$ | 71.1 (N.S.) | 106 | 13 | 48 |
| 32. | Wheat | $Y = 362 - 1.63N + 0.097N^2$ | 63.5 (N.S.) | 0 | 0 | 0 |
| | Rape | $Y = 515.5 - 2.3N + 0.032N^2$ | 18.6 (N.S.) | 0 | 0 | 0 |

* These curves have an indeterminate maximum as yields are increasing at an increasing rate.
In the case of trial 10 the increase is very slow and could be regarded as relatively non-responsive.

**Table 4 — Grouping of trials according to relative response to nitrogen fertilisers by wheat and rape**

| Absolute yield increases | | | Percentage yield increases | | | Rate of N needed for maximum yield | | |
|---|---|---|---|---|---|---|---|---|
| Wheat greater | Rape greater | No difference | Wheat greater | Rape greater | No difference | Wheat greater | Rape greater | No difference |
| 3 | 2 | 1 | 7 | 1 | 3 | 8 | 1 | 3 |
| 4 | 6 | *11 | 9 | 2 | 4 | 9 | 2 | 4 |
| 5 | 12 | 15 | 10 | 5 | *11 | 10 | 5 | *11 |
| 7 | 13 | *32 | 17 | 6 | 16 | 16 | 6 | *32 |
| 8 | 14 | | 19 | 8 | 29 | 17 | 7 | |
| 9 | 18 | | 28 | 12 | *32 | 19 | 12 | |
| 10 | 20 | | 31 | 13 | | 24 | 13 | |
| 16 | 21 | | | 14 | | 25 | 14 | |
| 17 | 22 | | | 15 | | 27 | 15 | |
| 19 | | | | 18 | | 28 | 18 | |
| 23 | | | | 20 | | 31 | 20 | |
| 24 | | | | 21 | | | 21 | |
| 25 | | | | 22 | | | 22 | |
| 26 | | | | 23 | | | 23 | |
| 27 | | | | 24 | | | 26 | |
| 28 | | | | 25 | | | 29 | |
| 29 | | | | 26 | | | 30 | |
| 30 | | | | 27 | | | | |
| 31 | | | | 28 | | | | |
| 19 trials | 9 trials | 4 trials | 7 trials | 19 trials | 6 trials | 11 trials | 17 trials | |

* No response to nitrogen on either crop.

**Table 5 — Average nitrogen response curves for wheat and rape, yield increases obtained and rates of nitrogen fertiliser required to obtain maximum yield**

| Average response curves | Maximum yield increase | Percentage yield increase | Rate of N for maximum yield |
|---|---|---|---|
| **Overall** (32 trials) | (kg ha$^{-1}$) | | (kg ha$^{-1}$) |
| Wheat*: $Y = 1928.8 + 9.66N - 0.052N^2$ | 449 | 23 | 93 |
| Rape : $Y = 628.6 + 4.06N - 0.018N^2$ | 229 | 36 | 113 |
| **Zone B** (13 trials) | | | |
| Wheat: $Y = 1877.2 + 8.2N - 0.35N^2$ | 480 | 26 | 117 |
| Rape: $Y = 484.6 + 3.03N - 0.016N^2$ | 143 | 30 | 95 |
| **Zone C** (18 trials) | | | |
| Wheat: $Y = 1954 + 10.37N - 0.063N^2$ | 427 | 22 | 82 |
| Rape: $Y = 731.5 + 4.92N - 0.02N^2$ | 303 | 41 | 123 |

* Where Y = seed yield in kg ha$^{-1}$ and N = rate of nitrogen in kg ha$^{-1}$.

**Table 6 – *Optimum economic rates of nitrogen for wheat and rape at 32 sites***
**(Wheat $84 tonne$^{-1}$, Rape $165 tonne$^{-1}$, Nitrogen $400$^{-1}$)**

| *More N needed on wheat than on rape* | | | *More N needed on rape than on wheat* | | | *Nitrogen requirement the same on wheat and rape* | | |
|---|---|---|---|---|---|---|---|---|
| Site | Optimum N rate | | Site | Optimum N rate | | Site | Optimum N rate | |
| | Wheat | Rape | | Wheat | Rape | | Wheat | Rape |
| | (kgNha$^{-1}$) | (kgNha$^{-1}$) | | (kgNha$^{-1}$) | (kgNha$^{-1}$) | | (kgNha$^{-1}$) | (kgNha$^{-1}$) |
| 4. | 95 | 87 | 11. | 97 | 246 | 3. | 0 | 0 |
| 5. | 68 | 6 | 2. | 0 | 46 | 6. | 0 | 0 |
| 7. | 68 | 0 | 13. | 0 | 7 | 8. | 45 | 43 |
| 10. | 41 | 2 | 14. | 17 | 122 | 9. | 0 | 0 |
| 16. | 30 | 0 | 15. | 61 | 97 | 11.* | 0 | 0 |
| 17. | 82 | 49 | 20. | 77 | 245 | 12. | 0 | 0 |
| 19. | 81 | 44 | 21. | 0 | 66 | 18 | 0 | 0 |
| 24. | 79 | 59 | 22. | 64 | 1205 | 23. | 98 | 100 |
| 26. | 152 | 137 | 30. | 49 | 57 | 25. | 0 | 0 |
| 27. | 51 | 27 | | | | 32.* | 0 | 0 |
| 28. | 16 | 0 | | | | | | |
| 29. | 59 | 0 | | | | | | |
| 31. | 43 | 22 | | | | | | |
| | 13 trials | | | 9 trials | | | 10 trials | |
| Average | 67 | 33 | Average | 38 | 111 | | | |

* No response to nitrogen on either crop.
Omitting site 26 (Toodyay).